Space Weather Technical Forecast

Issued on Tuesday, 03 September 2024 at 12:28 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: M-flares expected, slight chance of X-flares. Chance of G1-G2 Geomagnetic storms, mainly Day 2 (04 Sep). Increasing chance of reaching S1/Minor Radiation Storm level.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Activity is Moderate with five M-flares in the past 24hrs, the peak of which is M2.9 at 02/1343 UTC from AR3813 near the southeast limb. There are currently nine sunspot regions on the visible disc. AR3807 (Fki/Beta-Gamma-Delta), in the southwest, is the largest region and has developed a delta spot in the intermediate portion of the region. AR3806 (Eai/Beta-Gamma-Delta) near south centre disc consists of numerous spots and has developed a new delta within the trailing spot. AR3813 (Ekc/Beta-Gamma) close to the far southeast appears to be a large and complex region, but foreshortening prevents a confident assessment. A further region close to the southeast limb continues to emerge and may be magnetically connected to AR3813 and a region beyond the limb. All other regions are relatively simple and stable at present.

A far-sided CME was observed on coronagraph imagery around 03/0810UTC, analysis of this is currently underway. No other Earth directed CMEs have been observed in the last 24 hours.

Solar Wind / Geomagnetic Activity: Solar wind parameters as measured by ACE at L1 are currently at slightly elevated levels around 400 km/s, perhaps due to the onset of a weak High Speed Stream (HSS). Wind speeds have ranged from 370-470 km/s, with density below average. The Interplanetary Magnetic Field, Bt, was weak increasing to moderate after 02/1730 UTC, peaking at 12 nT. The north-south component, Bz, varied weakly before becoming mostly moderately northward directed between 02/1900 UTC and 03/0300 UTC. Phi angle was mostly negative (towards the Sun), switching to positive between 02/1945 UTC and 03/0017 UTC, after which it has fluctuated weakly. Geomagnetic activity was Quiet to Unsettled (Kp 1-3).

Energetic Particles / Solar Radiation: High energy (greater than 10 MeV) proton flux observed by GOES18 has been rising very slightly in response to the M5.5 flare on 01 Sep but remains below the S1 level, with a peak of 5 pfu at 03/0040 UTC. High energy electron flux (greater than 2MeV) observed at GOES16 was at background to moderate levels. The 24-hour fluence was below the Active threshold.

Four-Day Space Weather Forecast Summary

Solar Activity: Moderate activity is expected with a slight chance of isolated X-flares. The main flare risk is currently from AR3806, AR3807 and AR3813.

Solar Wind / Geomagnetic Activity: A filament eruption from 30/2330UTC may give a glancing blow on Day 1 (03 Sep). A large CME off the southeast limb on 01 Sep is expected to mostly pass well behind Earth's orbit, but a faint shock asymmetric halo means glancing impacts at Earth cannot be ruled out for this CME. The timing is low confidence, but perhaps later Day 1 (03 Sep) or more likely Day 2 (04 Sep). Solar winds are close to background levels at slightly elevated levels, likely due to waning HSS influence from a narrow negative polarity coronal hole.

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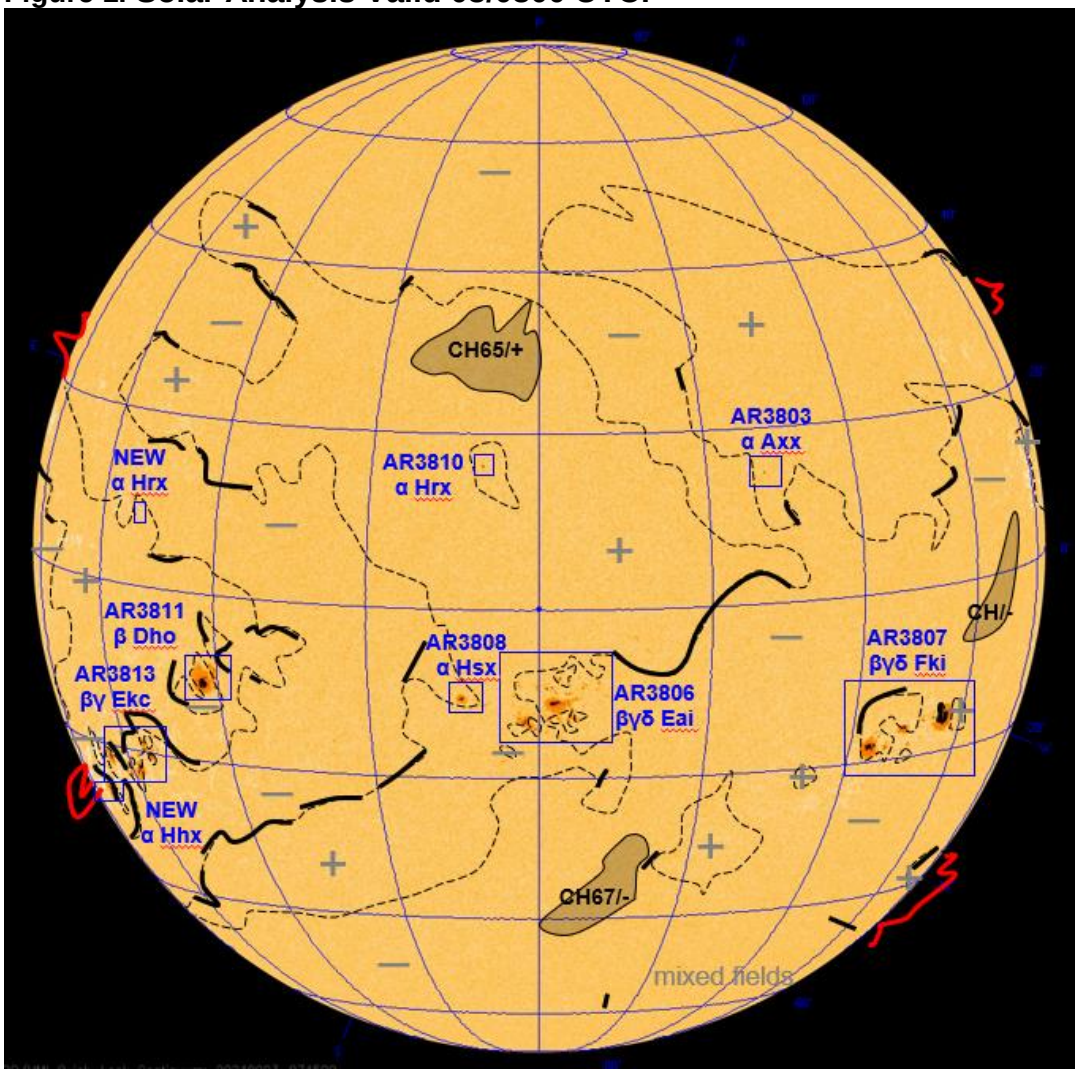
Slight enhancement to the solar winds is possible towards the end of Day 4 (06 Sep) should Earth connect to a HSS from CH65/+.

On the whole, mainly Quiet to Unsettled (Kp 1-3) activity is expected. There is a chance of G1-G2/Minor-Moderate Storm intervals (Kp 5-6), later Day 1 or during Day 2, should there be any peripheral impacts due to the CME from 01 Sep.

Energetic Particles / Solar Radiation: High energy proton flux is above background levels, but below the S1/Minor Radiation Storm threshold. There is a slight and increasing chance of exceeding S1 in the coming days. High energy electron flux is expected to remain at background to moderate levels, perhaps rising later in the period following any CME effects. There is a slight chance of fluence reaching the Active threshold by the end of the period.

Figure 1. Solar Analysis Valid 03/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Met Office Space Weather Technical Forecast

Geomagnetic Storms:

A filament eruption from 30/2330UTC is expected to miss behind Earth's orbit, but the analysis is low confidence due to poor available imagery, and so a glancing blow cannot be ruled out, perhaps on Day 1 (03 Sep). A large eruption off the southeast limb through the UTC afternoon of 01 Sep has been analysed, with the bulk of the CME passing well behind Earth's orbit. However, LASCO C3 imagery does show a faint asymmetric halo, likely shock from the eruption. As such, potential glancing impacts at Earth cannot be ruled out for this CME. The timing is low confidence - although the main portion of the CME will reach 1AU later on Day 1 (03 Sep), the shock is likely travelling slower and is more likely to reach Earth during Day 2 (04 Sep). A far-sided CME from earlier on 03 Sep produced an asymmetric halo which may had produced an element of shock that is Earth-directed. Enlil modelling of this feature is currently underway with low confidence of any timing of impacts at this stage.

Solar winds are at slightly elevated levels, likely due to the HSS from a narrow negative polarity coronal hole straddling the equator in the far western hemisphere. Whilst MOSWOC Enlil is suggesting a strong and broad coronal hole fast wind connection, this is not supported given the small size of the coronal hole, with low confidence that wind speeds may peak close to 500 km/s during Day 1 (03 Sep). The polarity of the coronal hole means that significant geomagnetic response is unlikely at this time of year. A HSS CH65/+ in the northeast of the disc may connect towards the end of Day 4, producing slight enhancement to the solar winds and producing slight geomagnetic enhancement. This is low confidence, with any arrival expected to be beyond the scope of the forecast period.

On the whole, mainly Quiet to Unsettled (Kp 1-3) activity is expected. There is a chance of G1-G2/Minor-Moderate Storm intervals (Kp 5-6), mainly on Day 2, should there be any peripheral impacts due to the CME from 01 Sep.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	20	30	5	5
Strong	G3	No	2	5	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
31/0830	Partial	Filament	NE	400 km/s	03/2100 UTC	Likely to miss.
01/1549	Partial	AR3813	SE Limb	1250 km/s	04/0600 UTC	Partial halo shock (not modelled in Enlil). May glance Earth. Low confidence.

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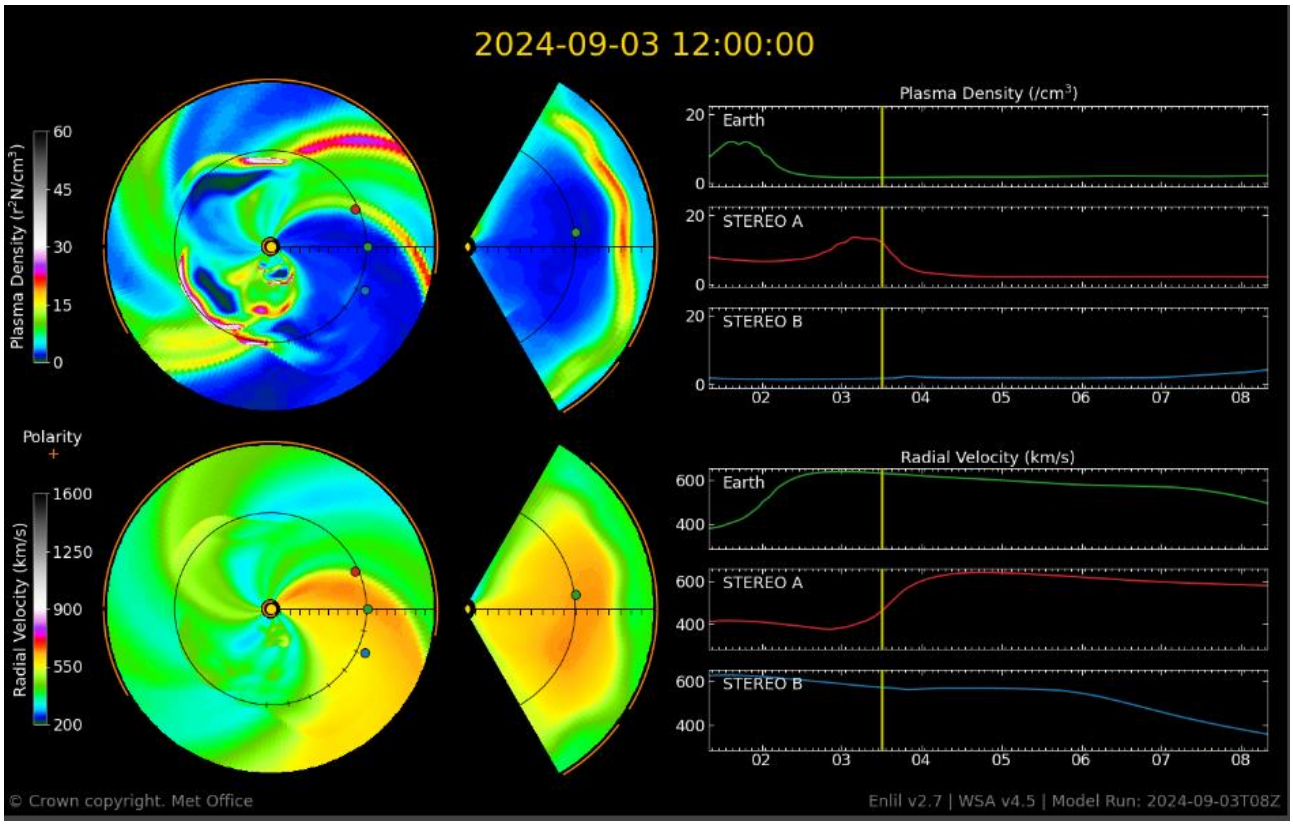
Figure 2: MOSWOC Enlil. CME from 01 Sep is only modelled to the bulk which misses Earth with the shock not visible in model space.



Radio Blackouts - X-Ray Flares:

Activity is Moderate with five M-flares in the past 24hrs, the peak of which was M2.9 at 02/1343 UTC from AR3813 near the southeast limb.

There are currently nine sunspot regions on the visible disc, two of which are unnumbered. AR3807 in the southwest remains the largest region with continued growth, decay, and consolidation in the central portion with the emergence of more mature penumbra and a faint delta spot. AR3806 lying south centre disc has shown some recent growth. Consisting of numerous spots AR3806 has developed at least two delta spots, one in the lead and one in the trailing group.

AR813 in the southeast appears to be a large and complex region, but due to foreshortening it is hard to distinguish the exact magnetic configuration at present. This region is showing significant looping in SDO imagery, however. The new region that lies in the far southeast is currently a unipolar region, however, there is evidence of a further spot emerging across the limb which may lie within the same area of plage and be considered part of the same sunspot group. This new region on the limb may be magnetically connected and contributing to the looping visible on AIA-0171 and AIA-0094 imagery.

All other regions are relatively small, simple and stable at present.

Further M-class flares are expected, with a chance of isolated X-class flares. Whilst AR3807 rotates off the disc early on Day 4 (06 Sep), the flare risk from this region will remain until it is around 24 hours over the limb, so a flat trend is maintained throughout.

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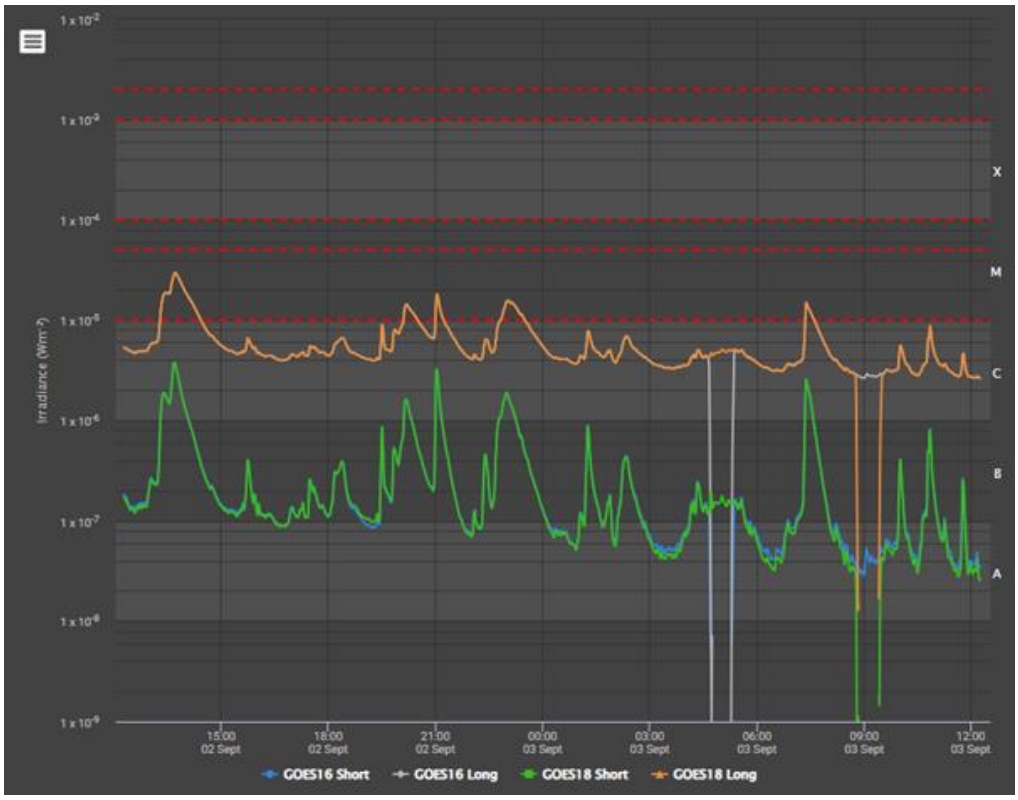
X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	80	80	80	80
Very Active	R3 to R5 X Class	No	25	25	25	25

Figure 3: GOES16 and GOES18 X-ray trace over past 24hrs



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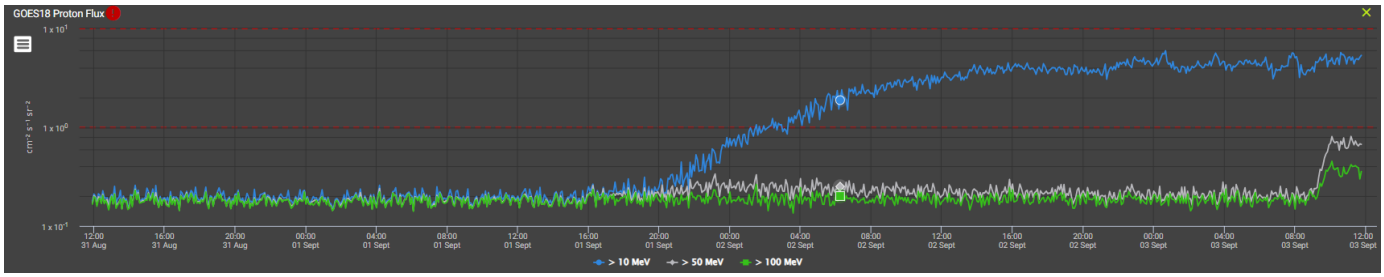
Solar Radiation Storms - (High Energy Protons):
High energy proton flux, as observed by GOES-18, is above background levels in response to the large eruption and M5.5 flare off the southeast limb during the UTC afternoon of 01 Sep. However, the upward trend appears to be levelling off and it is considered unlikely to reach the S1/Minor Radiation Storm threshold at this time, unless further notable flares occur. There are several regions on the disc which could give an increase in proton flux should they produce larger flares, including AR3807 and AR3806. Ordinarily, AR3813 would be considered a low risk of exceeding S1 from its current location, but given it has already produced a proton response at Earth from the east limb, this region will pose an increasing risk of proton flux increases as it rotates westward.

Overall, there is slight but increasing trend in the possibility of reaching the S1 threshold in the coming days, should there be any larger flares from any of the aforementioned regions.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	20	20	25	25
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

Figure 4: GOES18 Proton trace since 31 Aug showing rise following the M5.5 flare on 01 Sep



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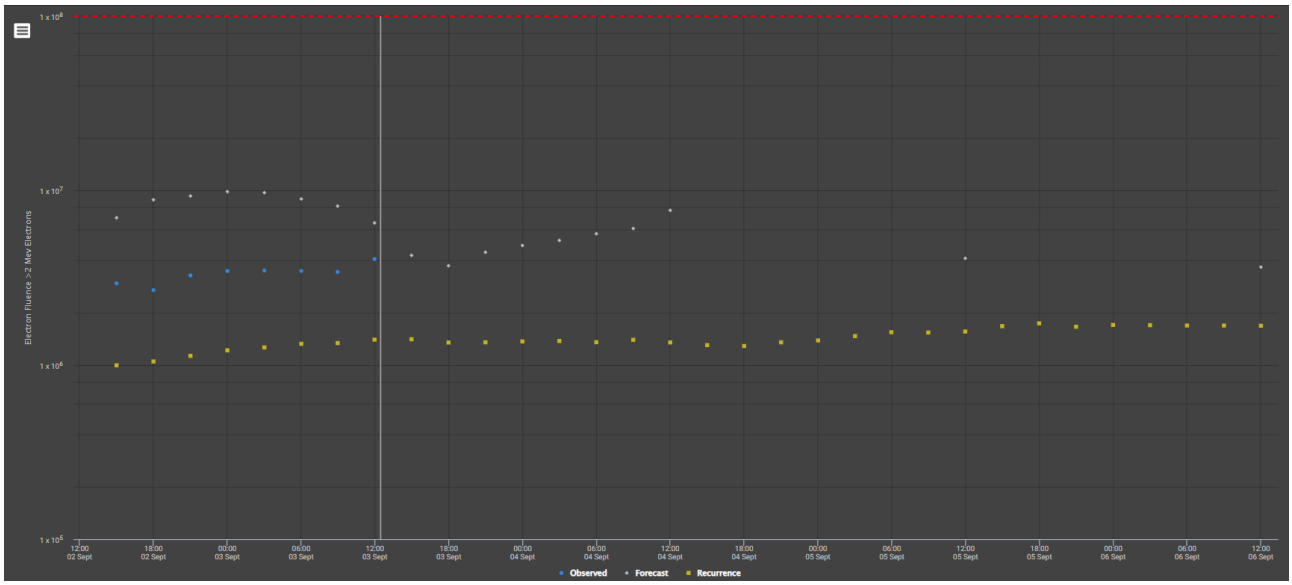
High Energy Electrons Event (≥ 2MeV):

High energy electron flux as observed by GOES-16 is at background to moderate levels, with recent CME effects driving a very minor increase in flux at the diurnal maxima. This is likely to gradually tail off over the next few days in the absence of CME influence. However, there is the potential for some CME shock at Earth on Days 1 to 2 (03-04 Sep), which may cause a sharp drop in electron flux to background levels in the short term. Depending on the level of geomagnetic response to this feature, it may then drive an increase in electron flux later in the period. Confidence is low, however, on whether these CME effects arrive at Earth or not.

Overall, the 24 hour fluence is expected to remain below the Active (1e8 integrated pfu) threshold for much of this period, perhaps with a rising trend later if we do see CME influence with a geomagnetic response. Therefore there is a slight chance of exceeding the Active threshold by the end of the period. MOSWOC REFM is showing the most likely forecast, below Active, but will not be taking into account any CME arrival.

GEO Electron Environment	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ 2 MeV ≥ $1x10^8$	No	1	1	5	10
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

Figure 5: MOSWOC REFM showing slight rise in forecast values. Does not take into account the potential for CME influence.



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